ADAPTING SUCCESSIONAL AGROFORESTRY SYSTEMS TO EUROPEAN CONTEXT WITH COLLABORATIVE METHODS

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Introduction

In the context of climate change and declining fossil fuel reserves, it is necessary to experiment with new agricultural systems (Griffon 2010). The Successional Agroforestry System was developed in Brazil with the aim to restore degraded land and at the same time create a productive agroecosystem which provides a livelihood for farmers (Goetsch 1992; Goetsch 1994). Some European agroforestry systems such as "forest-gardens" (de J Hart 1991; Whitefield 1996) share similarities with successional agroforestry systems. So far, forest-gardens are usually used by hobby gardeners and have not yet been developed for professional farming.

Drawing inspiration from South American agroforestry systems and European forest-gardens, a project was initiated to develop a participatory methodology for the design of larger scale multi-strata agroforestry systems with farmers in France. This project started in August 2015 after a meeting with farmers from an association working on chestnut (Rénova, Ariège, France). The promotion of the project through agro-ecological farmer networks (e.g. Osez-Agroecology, 2016) is also encouraging other farmers to get involved.

What is successional agroforestry?

The Successional Agroforestry System (SAF) is a land-use system developed by farmer-researcher Ernst Götsch, about 30 years ago, in Brazil. Similar systems have also been called "dynamic agroforestry" in Bolivia (Weckenbrock 2014), "syntropic agroforestry" in Brazil (AgendaGotsch, 2016) or "Regenerative analog agroforestry" (Vaz 2000). Such systems are developing dynamically in South America as evidenced by courses, university theses (Hofmann 2013) and video reports.

Ernst Götsch observed successional processes in nature and concluded that in order to improve and optimize the use of a given space he should attempt to mimic the dynamic of natural forest systems (Peneireiro 2002). This corresponds with the approach of agroecology, in which nature tends to be seen as the ideal model for agricultural systems (Gliessman et al. 1998). Thus, SAF can be considered as an agroecological system.

We suggest the following working definition: "Successional Agroforestry Systems draw inspiration from the process of species succession related to soil and climatic conditions, and attempt to mimic the functioning of forest ecosystems. They consist in sowing and planting a mix of species suitable for the given context, aiming at the highest possible diversity and at farmers' satisfaction." The core principles can be summarized as follows:

1. Direct sowing or planting of a mix of species which cover totally or partly the strata and the life cycles from annual species to trees.
2. Mulch production for a quick accumulation of organic matter using pruning and systematic trimming of some species (including non-woody plants and nitrogen-fixing trees). Practicing selective weeding allows to desirable spontaneous plants to be maintained in the system.
3. The plant communities and the main harvestable crops evolve. For example, in Brasilia (Brazil), the following crops are successively harvested: radish-salad-tomato-beans-maize (**Figure 1**) then manioc-sugar cane-papaya-banana (**Figure 2**) then cafe-starfruit-citrus-timber trees. Almost all species were present in the system from the beginning and the harvest allows the development of the future crops (Yana and Weinert 2002).

Figure 1: three-month old plot of SAF on the farm of Juã Pereira, near Brasilia, Brazil. The dominant crops include maize, onions, lettuce, cabbage and other vegetables.

Figure 2: two-year old plot of SAF on the same farm. The dominant crop is bananas. Coffee and citrus fruit are not yet in production.

Why should Successional Agroforestry Systems be adopted in France?
There are several reasons why SAF should be adopted in France. These include:
1. Growing interest manifested by both the scientific community and farmers.
2. Potential of increasing the yield per hectare through facilitation processes (Dupraz and Liagre 2008).
3. Potential to lower the impact of pests and diseases by increasing the three levels of agricultural biodiversity (genetic, species and ecosystem) (Ratnadass et al. 2012; Bhullar and Bhullar 2013; Guyot et al. 2015).
4. In agroforestry, in the first years after establishment, spontaneous flora are often in competition for water with the trees (Dupraz and Liagre 2008). This problem can be resolved by growing crops on the tree line.
5. The choice of species and the dynamic management of the vegetation by the farmer, can create substantial biomass, which, incorporated directly on the field, will increase soil fertility.
Particular attention will be paid to two potentially limiting factors of adoption which are the labour requirements associated with such intensive agroforestry systems and damage from animals such as rats, deer, and wild boars.

Goals of the research
As a result of the above, a PhD study was started in 2015. The goals of the research are:
1. To develop a methodology for the design of multi-strata agroforestry systems in cooperation with farmers
2. To find successful combinations of species and management practices
3. To compare traditional agroforestry installations with SAF for selected species.

Methodology
The approach adopted is a collaborative and bottom-up approach for co-conception of agroforestry systems and their future adoption by farmers (Franzel et al. 2006). Collaboration and information sharing are part of the culture of the farmers' network. The participating farmers can use knowledge from various sources such as: traditional farming practices, permaculture, personal on-farm observations and experiences, and information exchanged through the network.

The methodology is being developed through an on-going process; the first steps were the following:
1. Four farm visits in Daumazan-sur-Arize (Ariège, France) by the researcher from August 2015 to December 2015 allowed the identification of five interested farmers, their objectives, needs and system of values. Protocols were kept and shared for all discussions. The common aim of the collaboration is the design of a profitable multistrata agroforestry system.
2. The first meeting to plan the agroforestry system took place in February 2016. Work on classifying the species and a favourable plant association was started. An agreement was signed to underline the commitment between the PhD student and the farmers.

3. Further exchanges refined the design of the agroforestry systems and the goals to achieve, before the collective sowing and planting in March/April 2016. In collaboration with farmers, several observation documents will be built in order to measure progress on the commonly defined goals. For example, direct sowing of trees will be compared with tree planting in terms of plant quality, quantity of work, and overall costs for establishing the trees. The aim is that the cost of SAF should not be higher than classical agroforestry plantations. For this end, the objective is that the harvest of short and middle life-cycle plants will "pay for the installation of the trees" with Land Equivalent Ratios (LER) consistently greater than one.

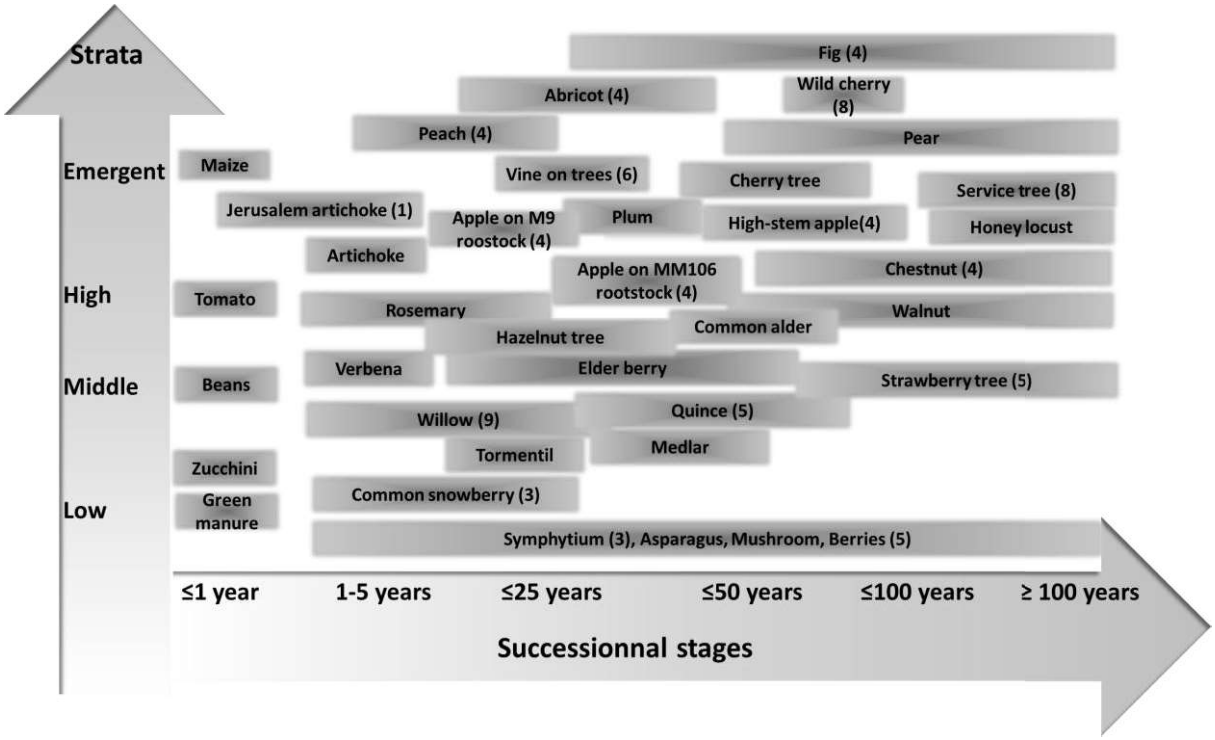

Figure 3: Draft of the successional stages and strata of some of the plants that the farmers in Ariège, France, intend to use in their SAF. In this context strata are used as a combination of the heights of the plants and the demand for light. Successional stage is used as a combination of plants' life-cycle and appearance in the succession of the system. The figure is adapted from Peneireiro (2002).

Legend:

(1) Disliked by some farmers as it is expected to attract mice
(2) Covering the soil to avoid herbaceous competition with young trees
(3) Already adopted and used in combination with fruit trees
(4) Includes local varieties, often associated with a high value by an associated processor
(5) Good value anticipated from an associated processor (already or expected in the future)
(6) Revive an old-practice
(7) Adopted in one particular context to improve poor soil through nitrogen fixation and biomass production
(8) Considered to be valuable broad-leaved trees
(9) Demand for baskets and biomass production for the improvement of the system

Figure 3 shows a draft schedule with crops that can be used for SAF in Europe. The table was used as a tool to discuss with the farmers the succession of the species in time and space in their future agroforestry system. This is not a definitive classification and not all the plants which will be used are quoted. Some plants are used by all the farmers (chestnut, apple trees, and common comfrey (*Symphytum officinale*). Agroforestry systems will have between 10 and 30 species including cultivated wild plants. In the legend below, farmers' arguments to choose particular plants are given.

Conclusion

This PhD research focuses on the adoption of forest gardens and Successional Agroforestry Systems in France. Participatory methods are used for this farmer-researcher collaboration. People interested in the research are welcome to participate in the process.

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